CLAIMS

1. Transmission system (10) comprising two optical signals (z_1, z_2) transmitted over the same fibre (15) at the same wavelength but with orthogonal states of polarization, characterised by receiving apparatus (10) capable of filtering the two components with orthogonal polarization of the signal received in accordance with a transfer matrix $H(\omega)$ controlled dynamically on the basis of the output signals (s_1,s_2) in such a manner as to approximate the reverse transfer matrix of the fibre in the region of the spectrum occupied by the signal so as to compensate for the polarization mode dispersion and the polarization rotation introduced by the fibre while eliminating distortion and mutual interference effects for both the signals and obtaining at output an approximate repetition of the two signals transmitted.

2. System in accordance with claim 1 characterized in that the transfer matrix $H(\omega)$ is:

$$H(\omega) = e^{-j\frac{N}{2}\omega\tau}\begin{pmatrix} C(\omega) & D(\omega) \\ -D^*(\omega) & C^*(\omega) \end{pmatrix} \qquad (1)$$

with the two functions $C(\omega)$ and $D(\omega)$ given by:

$$C(\omega) = \sum_{k=0}^{N} c_k e^{-j(k-N/2)\omega\tau} \qquad (2)$$

$$D(\omega) = \sum_{k=0}^{N} d_k e^{-j(k-N/2)\omega\tau} \qquad (3)$$

with

$$|C(\omega)|^2 + |D(\omega)|^2 = 1 \quad (4)$$

where τ is an appropriate temporal delay and c_k and d_k are the complex coefficients dynamically controlled on the basis of the output signals.

3. System in accordance with claim 1 characterized in that the receiving apparatus 10 comprises at input a polarization splitter (16) which divides the signal received into two components on the basis of the polarization and a demultiplexing device (17) which filters the two components approximating the reverse transfer matrix of the fibre.

4. System in accordance with claim 3 characterized in that the filtered components (y_1, y_2) are applied to photodetection means (18) and the signals obtained (s_1, s_2) from the photodetection are sent to clock and data recovery circuits.

5. System in accordance with claim 3 characterized in that the parameters of the demultiplexing device (17) are dynamically controlled to minimize a set cost function.

6. System in accordance with claim 5 characterized in that the cost function is a function of the sum of the mean square errors for the two output signals.

7. System in accordance with claim 5 characterized in that the cost function is a function of the sum of the openings of the rough diagrams for the two output signals.

8. System in accordance with claim 3 characterized in that the demultiplexing device (17) is a planar lightguie circuit comprising a cascade of N identical elements each comprising an interferometrical structure (21) with delay τ between the two optical paths and a phase modulator (22) controlled by the parameter ϕ_n and a variable coupler (23) controlled by the parameter θ_n.

9. System in accordance with claim 8 characterized in that at the input of the demultiplexing device there is another variable coupler θ_n.

10. System in accordance with claim 8 characterized in that some, or all, of the N elements of the device (17) consist of a larger number of phase modulators (22) and variable couplers (23).

11. System in accordance with claim 9 characterized in that the overall transfer matrix of the device is

$$H(\omega) = \left[\prod_{n=N}^{1} (H_{\theta_n} H_{\phi_n} H_{\tau}(\omega)) \right] H_{\theta_0} \qquad (6)$$

12. System in accordance with claim 11 characterized in that the matrix is a frequency dependent unitary transfer matrix and can be written in the following form

$$H(\omega)=e^{-j\frac{N}{2}\omega\tau}\begin{pmatrix} C(\omega) & D(\omega) \\ -D^*(\omega) & C^*(\omega) \end{pmatrix} \tag{1}$$

$$|C(\omega)|^2+|D(\omega)|^2=1 \tag{4}$$

with the two functions $C(\omega)$ and $D(\omega)$ represented by their Fourier series expansion (N+1 terms)

$$C(\omega)=\sum_{k=0}^{N} c_k e^{-j(k-N/2)\omega\tau} \tag{2}$$

$$D(\omega)=\sum_{k=0}^{N} d_k e^{-j(k-N/2)\omega\tau} \tag{3}$$

where c_k and d_k are complex coefficients linked unlinearly to the real control parameters of the device.

13. System in accordance with claim 3 characterized in that the demultiplexing device (17) comprises a cascade of polarization controllers (PC) and polarization maintaining fibres (PMF).

14. Apparatus (10) for receiving an polarization multiplexed optical signal which has been transmitted over a fibre (15) and is made up of two polarization multiplexed signals (z_1, z_2) and for performing simultaneous compensation of polarization mode

dispersion and demultiplexing of the two signals, characterised by means (17) which filter the two components with orthogonal polarization of the received signal in accordance with a transfer matrix $H(\omega)$ controlled dynamically on the basis of the output signals so as to approximate the reverse transfer matrix of the fibre in the region of the spectrum occupied by the signal so as to compensate for the polarization mode dispersion and the polarization rotation introduced by the fibre while eliminating effects of distortion and mutual interference for both the signals and obtaining at output an approximate repetition of the two transmitted signals.

15. Apparatus in accordance with claim 14 characterized in that the transfer matrix $H(\omega)$ is:

$$H(\omega) = e^{-j\frac{N}{2}\omega\tau}\begin{pmatrix} C(\omega) & D(\omega) \\ -D^*(\omega) & C^*(\omega) \end{pmatrix} \tag{1}$$

with the two functions $C(\omega)$ and $D(\omega)$ represented by their Fourier series expansion (N+1 terms):

$$C(\omega) = \sum_{k=0}^{N} c_k e^{-j(k-N/2)\omega\tau} \tag{2}$$

$$D(\omega) = \sum_{k=0}^{N} d_k e^{-j(k-N/2)\omega\tau} \tag{3}$$

with

$$|C(\omega)|^2 + |D(\omega)|^2 = 1 \tag{4}$$

where τ is an appropriate temporal delay and c_k and d_k are the complex coefficients controlled dynamically on the basis of the output signals.

16. Receiving apparatus in accordance with claim 14 characterized in that the means comprises an input polarization splitter (16) that divides the received signal into two components on the basis of polarization and a demultiplexing device (17) that filters the two components approximating the reverse transfer matrix of the fibre.

17. Receiving apparatus in accordance with claim 16 characterized in that the filtered components (y_1, y_2) are applied to photodetection means (18) and the signals obtained from photodetection (s_1, s_2) are sent to clock and data recovery circuits.

18. Receiving apparatus in accordance with claim 16 characterized in that the demultiplexing device (17) parameters are dynamically controlled to minimize a set cost function.

19. Receiving apparatus in accordance with claim 18 characterized in that the cost function is a function of the sum of the mean square errors for the two output signals.

20. Receiving apparatus in accordance with claim 18 characterized in that the cost function is a function of the sum of the openings of the rough diagrams for the two output signals.

21. Receiving apparatus in accordance with claim 16 characterized in that the demultiplexing device (17) is planar lightguide circuit and comprises a cascade of N identical elements each comprising an interferometrical structure (21) with delay τ between the two optical paths, a phase modulator (22) controlled by the parameter ϕ_n and a variable coupler (23) controlled by the parameter θ_n.

22. Receiving apparatus in accordance with claim 21 characterized in that at the input of the device (17) there is another variable coupler θ_n .

23. Receiving apparatus in accordance with claim 21 characterized in that some or all of the N elements of the device consist of a higher number of phase modulators (22) and variable couplers (23).

24. Receiving apparatus in accordance with claim 21 characterized in that the overall transfer matrix of the device is

$$H(\omega) = \left[\prod_{n=N}^{1} (H_{\theta_n} H_{\phi_n} H_{\tau}(\omega)) \right] H_{\theta_0} \qquad (6)$$

25. Receiving apparatus in accordance with claim 24 characterized in that the matrix is a frequency dependent unitary transfer matrix and can be written in the following form

$$H(\omega) = e^{-j\frac{N}{2}\omega\tau}\begin{pmatrix} C(\omega) & D(\omega) \\ -D^*(\omega) & C^*(\omega) \end{pmatrix} \tag{1}$$

$$|C(\omega)|^2 + |D(\omega)|^2 = 1 \tag{4}$$

with the two functions $C(\omega)$ and $D(\omega)$ represented by their Fourier series expansion (N+1 terms)

$$C(\omega) = \sum_{k=0}^{N} c_k e^{-j(k-N/2)\omega\tau} \tag{2}$$

$$D(\omega) = \sum_{k=0}^{N} d_k e^{-j(k-N/2)\omega\tau} \tag{3}$$

where c_k and d_k are complex coefficients linked unlinearly to the real control parameters of the device.

26. Receiving apparatus in accordance with claim 16 characterized in that the demultiplexing device (17) comprises a cascade of polarization controllers (PC) and polarization maintaining fibres (PMF).

27. Transmission method comprising two optical signals transmitted over the same fibre at the same wavelength but with orthogonal polarization and that at the receiving side filters the two components with orthogonal polarization of the signal received in accordance with a transfer matrix *H(ω)* controlled dynamically on the basis of the signals output so as to approximate the reverse transfer matrix of the fibre in the region of the spectrum occupied by the signal so as to compensate for the polarization mode dispersion and the polarization rotation introduced by the fibre while eliminating distortion and mutual interference effects for both signals and obtaining at output an approximate repetition of the two transmitted signals.

28. Method in accordance with claim 27 characterized in that the transfer matrix *H(ω)* is:

$$H(\omega) = e^{-j\frac{N}{2}\omega\tau}\begin{pmatrix} C(\omega) & D(\omega) \\ -D^*(\omega) & C^*(\omega) \end{pmatrix} \qquad (1)$$

with the two functions $C(\omega)$ and $D(\omega)$ represented by their Fourier series expansion (N+1 terms):

$$C(\omega) = \sum_{k=0}^{N} c_k e^{-j(k-N/2)\omega\tau} \qquad (2)$$

$$D(\omega) = \sum_{k=0}^{N} d_k e^{-j(k-N/2)\omega\tau} \qquad (3)$$

with

$$|C(\omega)|^2 + |D(\omega)|^2 = 1 \tag{4}$$

where τ is an appropriate temporal delay and c_k and d_k are the complex coefficients dynamically controlled on the basis of the signals output.